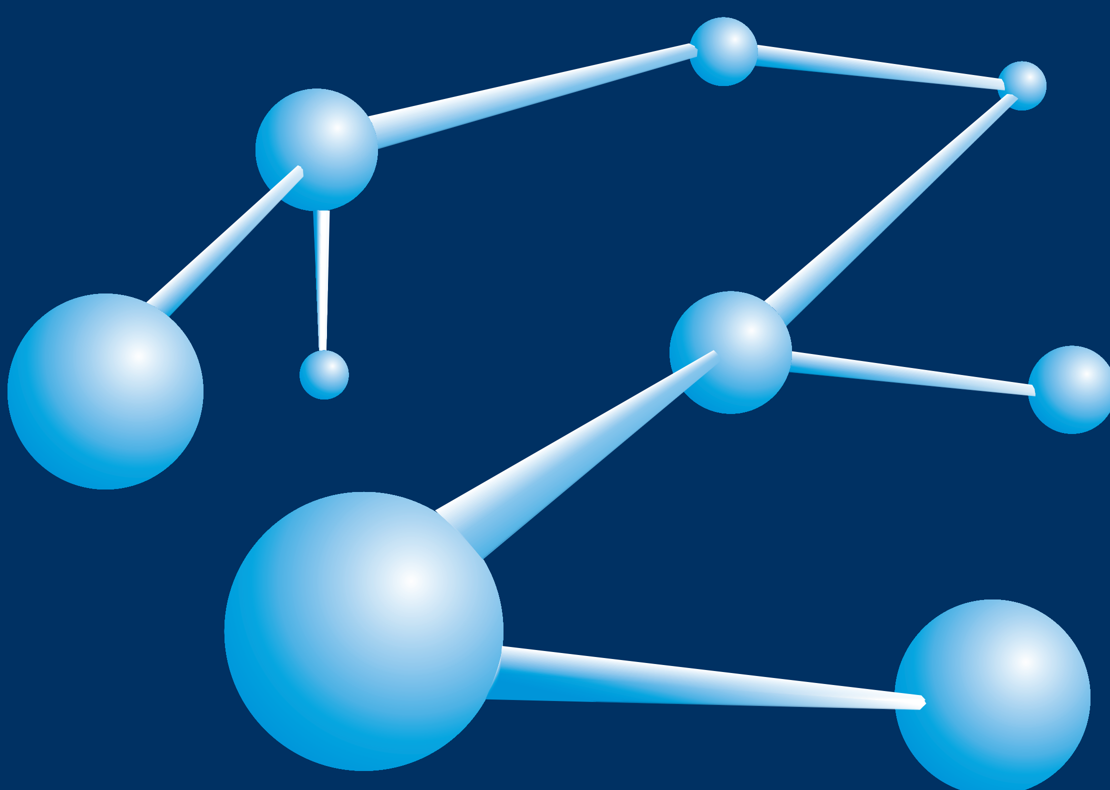
# EXPANDING THE SPATIAL COVERAGE OF MARYLAND'S NETWORK OF NON-TIDAL WATER QUALITY MONITORING STATIONS



CHESAPEAKE BAY AND
WATERSHED PROGRAMS
MONITORING AND
NON-TIDAL ASSESSMENT

TECHNICAL MEMORANDUM

# Expanding the Spatial Coverage of Maryland's Network of Water Quality Monitoring Stations

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**Abstract**

Time series data from the non-tidal stations of the Core/Trends Water Quality Network were analyzed to determine how sampling frequency could be reduced at some stations and allow new stations to be initiated in areas of the state that are presently not sampled. The results showed that sampling frequency could be reduced at fifteen currently operating stations which would allow seven new stations to be selected. Eight new locations with operating flow gages are proposed for addition to the network. An alternative strategy is proposed that would allow reinstating eleven stations where sampling was suspended in April 1999 for budgetary reasons. Combinations of the two strategies are also possible.

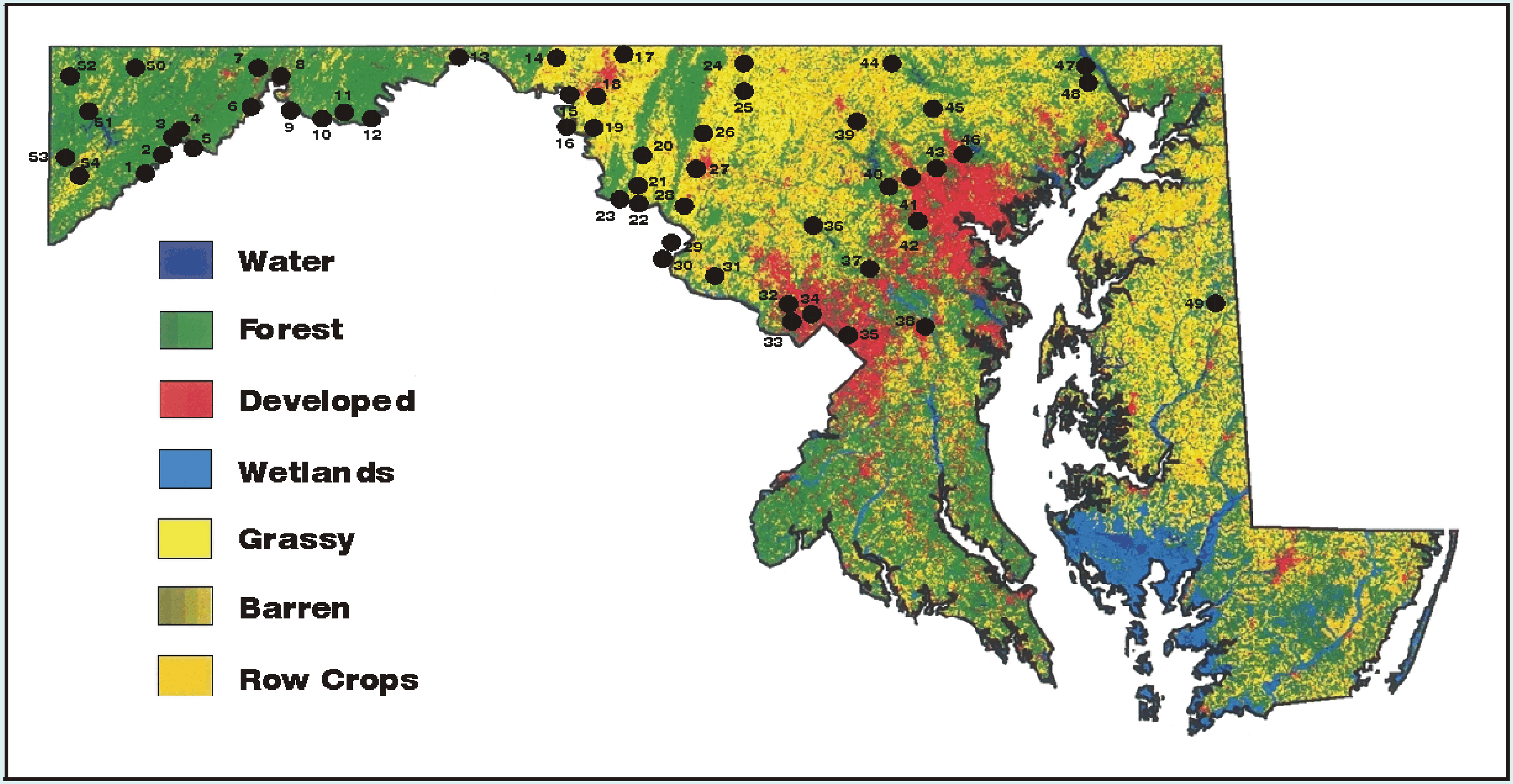
**Introduction**

The non-tidal stations of the Maryland ambient fixed-station water quality monitoring program (a sub-set of the Core/Trends Network) was initiated in 1974 at 29 sampling stations, these are referred to as the Core stations. Twenty-five more stations were added throughout the 1970's and early 1980's such that 54 locations have been sampled monthly since 1986. These are referred to as Trend stations and use identical collection and analytical methods as Core stations. Budgetary deficiencies necessitated reduction in sampling frequency at eleven Trend stations beginning in April 1999 (Figure 1). These stations are included in this analysis as it is anticipated that sampling will resume if funding becomes available.

Most stations are located at bridge crossings and 31 of the stations were originally co-located with USGS stream flow gages; however, only twenty-five gages remain active (Table 1). Twenty parameters are sampled for most stations each month. Some parameters are measured in situ and others are analyzed in the laboratory on filtered (0.70$\mu$) or whole water samples. Ten additional parameter values are calculated from the measured parameters (Table 2). The water quality data are censored by detection limit values. Below detection limit values are replaced by half the detection limit.

This ambient fixed-station monitoring network was initiated to monitor progress related to reduction of point source discharges and changes in water quality attendant to population increase. Network results are incorporated into the 305(b) reporting to the USEPA. Results of status and trends analysis are also made available on the Internet at: http://www.dnr.state.md.us/streams/status_trends/index.html . Currently, in addition to point source information, long-term water quality data are needed for assessment of non-point source impacts in areas of Maryland that are not now being sampled. The type of time-series information on water quality produced by the network is also needed to determine if pollution abatement and/or watershed restoration efforts are effective. The purpose of the analyses described in this report is to

**Figure 1. Core/ Trend sampling Stations and Associated Land Cover. MRLC, 1990**



## Table 1. Core/Trend Non-tidal Sampling Stations

| C/T # | Station Name | USGS Gage # | Year Gage was Discontinued | Stream Basin | County | MD 8-Digit | Map Key |
|---|---|---|---|---|---|---|---|
| 1 | NBP0689 | 1595500 | 1985 | North Branch Potomac | Garrett | 2141005 | 133 |
| 2 | NBP0534 | | | North Branch Potomac | Garrett | 2141005 | 133 |
| 3 | SAV0000* | 1597500 | | Savage River | Garrett | 2141006 | 134 |
| 4 | GEO0009 | 1599000 | | Georges Creek | Allegany | 2141004 | 132 |
| 5 | NBP0461* | | | North Branch Potomac | Allegany | 2141001 | 129 |
| 6 | NBP0326 | 1600000 | 1985 | North Branch Potomac | Allegany | 2141001 | 129 |
| 7 | BDK0000* | | | Braddock Run | Allegany | 2141003 | 131 |
| 8 | WIL0013* | 1601500 | | Wills Creek | Allegany | 2141003 | 131 |
| 9 | NBP0103 | | | North Branch Potomac | Allegany | 2141001 | 129 |
| 10 | NBP0023* | | | North Branch Potomac | Allegany | 2141001 | 129 |
| 11 | TOW0030 | 1609000 | 1981 | Town Creek | Allegany | 2140512 | 128 |
| 12 | POT2766* | 1610000 | | Potomac River | Allegany | 2140508 | 124 |
| 13 | POT2386 | 1613000 | | Potomac River | Washington | 2140508 | 124 |
| 14 | CON0180 | 1614500 | | Conococheague | Washington | 2140504 | 120 |
| 15 | CON0005 | | | Conococheague | Washington | 2140504 | 120 |
| 16 | POT1830 | 1618000 | 1993 | Potomac River | Washington | 2140501 | 117 |
| 17 | ANT0366 | 1619000 | 1981 | Antietam Creek | Washington | 2140502 | 118 |
| 18 | ANT0203 | | | Antietam Creek | Washington | 2140502 | 118 |
| 19 | ANT0044 | 1619500 | | Antietam Creek | Washington | 2140502 | 118 |
| 20 | CAC0148 | 1637500 | | Catoctin Creek | Frederick | 2140305 | 116 |
| 21 | CAC0031 | | | Catoctin Creek | Frederick | 2140305 | 116 |
| 22 | POT1595(MD) | 1638500 | | Potomac River | Frederick | 2140301 | 112 |
| 23 | POT1596(VA) | | | Potomac River | Frederick | 2140301 | 112 |
| 24 | MON0528 | 1639000 | | Monocacy | Frederick | 2140303 | 114 |
| 25 | BPC0035 | 1639500 | | Big Pipe Creek | Frederick | 2140304 | 115 |
| 26 | MON0269 | | | Monocacy | Frederick | 2140303 | 114 |
| 27 | MON 0155 | 1643000 | | Monocacy | Frederick | 2140302 | 113 |
| 28 | MON0020 | | | Monocacy | Frederick | 2140302 | 113 |
| 29 | POT1471(MD) | | | Potomac River | Montgomery | 2140202 | 105 |
| 30 | POT1472(VA) | | | Potomac River | Montgomery | 2140202 | 105 |
| 31 | SEN0008 | 1645000 | | Seneca Creek | Montgomery | 2140208 | 111 |
| 32 | CJB0005 | | | Cabin John Branch | Montgomery | 2140207 | 110 |
| 33 | POT1184 | 1646500 | | Potomac River | Montgomery | 2140202 | 105 |
| 34 | RCM0111 | | | Rock Creek | Montgomery | 2140206 | 109 |
| 35 | ANA0082 | 1649500 | | Anacostia River | Prince Georges | 2140205 | 108 |
| 36 | PXT0972 | 1591000 | | Patuxent | Montgomery | 2131108 | 89 |
| 37 | PXT0809 | 1592500 | | Patuxent | Prince Georges | 2131107 | 88 |
| 38 | PXT0603 | 1594440 | | Patuxent | Anne Arundel | 2131104 | 85 |
| 39 | NPA0165 | 1586000 | | North Br. Patapsco | Carroll | 2130907 | 75 |
| 40 | PAT0285 | 1589000 | 1995 | Patapsco | Baltimore | 2130906 | 74 |
| 41 | PAT0176 | | | Patapsco | Baltimore | 2130906 | 74 |
| 42 | GWN0115 | 1589300 | 1998 | Gwynns Falls | Baltimore | 2130905 | 73 |
| 43 | JON0184 | 1589440 | | Jones Falls | Baltimore | 2130904 | 72 |
| 44 | GUN0476 | | | Gunpowder | Baltimore | 2130806 | 67 |
| 45 | GUN0258 | | | Gunpowder | Baltimore | 2130805 | 66 |
| 46 | GUN0125 | | | Gunpowder | Baltimore | 2130802 | 63 |
| 47 | SUS0109 | 1578310 | | Susquehanna River | Harford | 2120201 | 2 |
| 48 | DER0015 | | | Deer Creek | Harford | 2120202 | 3 |
| 49 | CHO0626 | 1491000 | | Choptank River | Caroline | 2130404 | 32 |
| 50 | CAS0479* | 3078000 | | Casselman River | Garrett | 5020204 | 138 |
| 51 | CCR0001* | | | Cherry Creek | Garrett | 5020203 | 137 |
| 52 | YOU0925* | 3076500 | | Youghiogheny River | Garrett | 5020201 | 135 |
| 53 | YOU1139* | | | Youghiogheny River | Garrett | 5020201 | 135 |
| 54 | LYO0004* | | | Little Youghiogheny | Garrett | 5020202 | 136 |

*Sampling suspended in April 1999 because of budgetary deficiencies

**Table 2. Core/Trends Monitoring Parameters, Frequency of Collection, Limits and Detection and Method of Calculation.**

| Parameter | Type of Sample | Detection Limit 1976-1984 | Method of Calculation |
|---|---|---|---|
| Temperature (T) | In situ Measurement | -10°C | |
| Flow (gaging stations only) | In situ Measurement | 0.01cfs | |
| Dissolved Oxygen (DO) | In situ Measurement | 0.0 mg/L | |
| pH | In situ Measurement | 0.1 unit | |
| Specific Conductance | In situ Measurement | 1 $\mu$mhos | |
| Total Organic Carbon (TOC) | Grab Sample | 1 mg/L | |
| Ammonium (NH4) | Grab Sample | 0.008 mg/L | |
| Total Kjeldahl Nitrogen (TKN) | Grab Sample | 0.1 mg/L | |
| Nitrite + Nitrate (NO23) | Grab Sample | 0.02 mg/L | |
| Nitrite (NO2) | Grab Sample | 0.002 mg/L | |
| Ortho-Phosphate (PO4) | Grab Sample | 0.004 mg/L | |
| Suspended Solids (TSS) | Grab Sample | 1.0 mg/L | |
| *Turbidity | Grab Sample | 0.01 NTU | |
| *Chlorophyll “a”, active | Grab Sample | 0.01 $\mu$g/L | |
| *Phaeophytin “a” | Grab Sample | | |
| *Coliforms, Fecal | Grab Sample | 3 MPN/100mL | |
| *Coliforms, Total | Grab Sample | 3 MPN/100mL | |
| Total Phosphorus (TP) | Grab Sample | 0.01 mg/L | |
| *Alkalinity, Total | Grab Sample | 0.1 mg/L $CaCO_3$ | |
| Total Nitrogen (TN) | Calculated | | TKNW + NO23 |
| Dissolved Inorganic Nitrogen (DIN) | Calculated | | NO23F + NH4F |
| Dissolved Organic Nitrogen (DON) | Calculated | | TKNF - NH4F |
| Dissolved Organic Phosphorus (DOP) | Calculated | | TDP - PO4F |
| Total Dissolved Nitrogen (TDN) | Calculated | | TKNF + NO23F |
| Total Organic Phosphorus (TOP) | Calculated | | TP - PO4F |
| Total Organic Nitrogen (TON) | Calculated | | TKNW - NH4F |
| Particulate Phosphorus (PP) | Calculated | | TP - TDP |
| Nitrate (N) | Calculated | | NO23 - NO2 |
| Particulate Carbon (PC) | Calculated | | TOC - DOC |

*Collected for most but not all stations. W = whole sample, F = filtered determine how greater spatial coverage of the state can be achieved without a decrease in our ability to detect trends at the 54 present stations and with no increased cost for the program.

In it's present configuration, the non-tidal Core/Trends water quality monitoring network has one to three stations in 38 of the 138, 8-digit watersheds in Maryland (Figure 2, Table 3). Watersheds in the more populated regions of the state (Baltimore and Washington) and areas to the west, along the Potomac River, have more water quality stations, a spatial distribution that is consistent with the initial design objectives for the network. Monitoring emphasis is now expanding to include not only point source assessment, but also the assessment of non-point source agricultural activities and impacts of increasing urbanization. The non-tidal Core/Trends network must therefore increase it's spatial coverage by monitoring at new stations in non-tidal watersheds of the southern coastal plain region while preserving the ability of the network to detect trends at existing stations that have been sampled for several years.

Presently, status and trends are based upon concentration values from monthly sampling. Estimation of constituent loading (the product of concentration and flow) is desirable, however, to determine relative contributions among source areas or land types. It is, therefore, crucial to have flow measurements in temporal and spatial concert with concentration numbers. Additionally , accurate load estimates necessitate having concentrations measured over a range of flow so that integration over an annual cycle captures the flow/concentration relationship which can vary depending on source type (i.e., point source - POTW, or area source-agricultural amendments).

## Methods

Statistical analyses of the time series from 1986-1998 at 54 non-tidal Core/Trends stations was undertaken to determine the significance of water quality trends for parameters of interest for present assessment purposes (total nitrogen, total phosphorous and total suspended solids). Results of this time series analyses was then compared to identical analysis using half of the data set. Half data sets used only even months (e.g., February, April, etc.) and, then, only odd months (e.g., January, March, etc.). A station was considered for reduced sampling frequency if analysis of the time series under the reduced sampling frequency scenario did not alter the conclusion that one would reach by using the full data set. Therefore, a station was considered to be a candidate for reduced sampling frequency if one of the following conditions were met:

1. If analyses using the full (monthly) and reduced (bi-monthly) data sets both yielded a significant temporal trend (at the $p < 0.01$ level) and the slope parameter was in the same direction, or

2. If temporal trends were not significant using either sampling frequency data sets (i.e., monthly or bi-monthly) for <u>all</u> of the three parameters (TP, TN and TSS).

The Seasonal Kendall Tau test was used on all data sets to determine if trends existed and a summary of the results is in the Appendix.

## Results

A total of 21 of the 54 stations matched one of the above conditions for all parameters. Six of those stations, however, were among the eleven where sampling was suspended in April, 1999

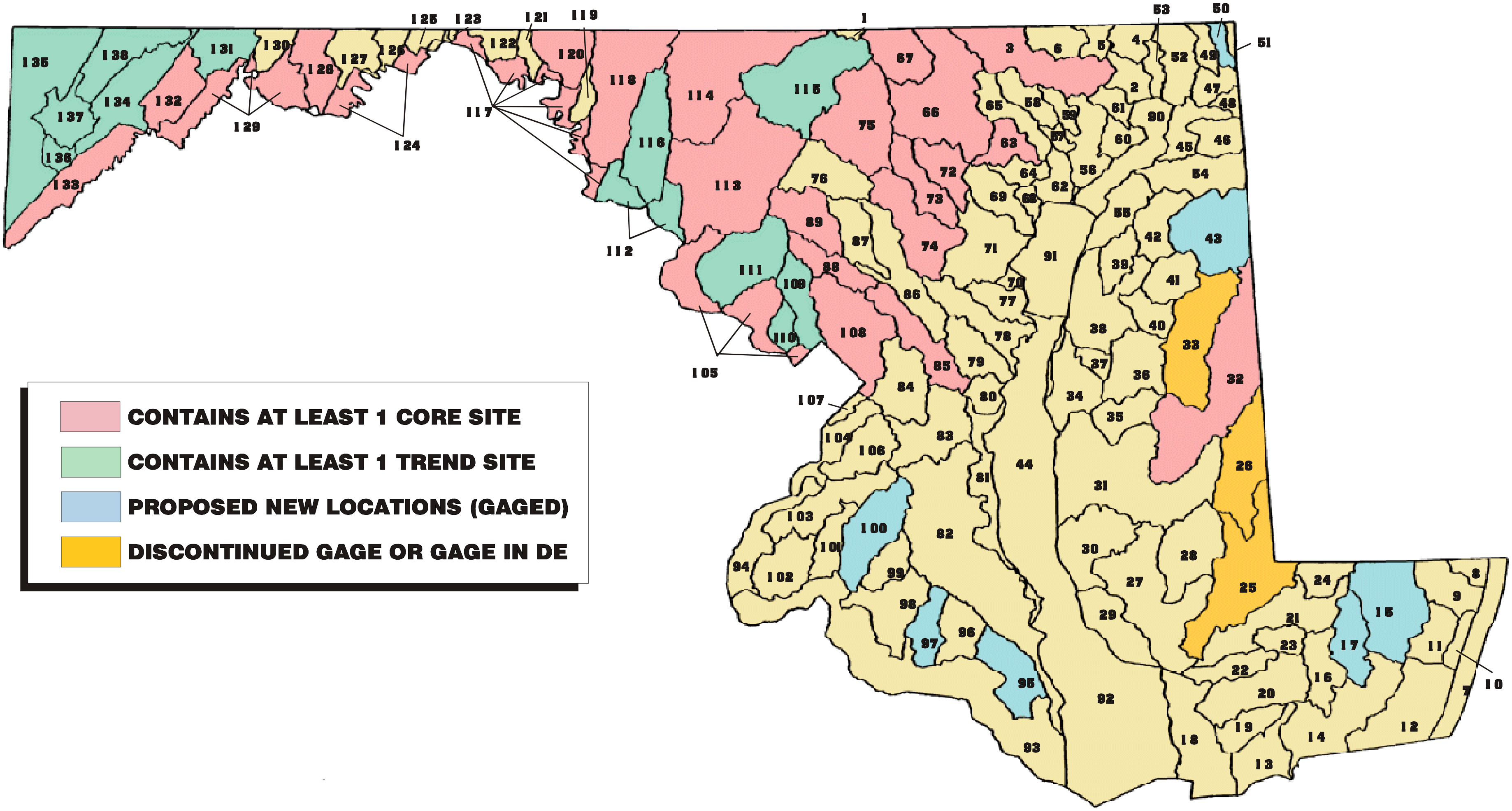



**Figure** 2. Existing and proposed spatial coverage of Maryland by Non-tidal Core/Trends Ambient Water Monitoring Network.

# Table 3. Map #, Maryland 8-digit Watershed Code and Watershed Name

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 020503 | Conewago Creek | 47 | 02130603 | Upper Elk River | 93 | 0214010 | Potomac River L tidal |
| 2 | 021202 | L Susquehanna River | 48 | 02130604 | Back Creek | 94 | 0214010 | Potomac River M tidal |
| 3 | 021202 | Deer Creek | 49 | 02130605 | Little Elk Creek | 95 | 0214010 | St. Mary's River |
| 4 | 021202 | Octoraro Creek | 50 | 02130606 | Big Elk Creek | 96 | 0214010 | Breton Bay |
| 5 | 021202 | Conowingo Dam Susq | 51 | 02130607 | Christina River | 97 | 0214010 | St. Clements Bay |
| 6 | 021202 | Broad Creek | 52 | 02130608 | Northeast River | 98 | 0214010 | Wicomico River |
| 7 | 021301 | Atlantic Ocean | 53 | 02130609 | Furnace Bay | 99 | 0214010 | Gilbert Swamp |
| 8 | 021301 | Assawoman Bay | 54 | 02130610 | Sassafras River | 100 | 0214010 | Zekiah Swamp |
| 9 | 021301 | Isle of Wight Bay | 55 | 02130611 | Stillpond-Fairlee | 101 | 0214010 | Port Tobacco River |
| 10 | 021301 | Sinepuxent Bay | 56 | 02130701 | Bush River | 102 | 0214011 | Nanjemoy Creek |
| 11 | 021301 | Newport Bay | 57 | 02130702 | Lower Winters Run | 103 | 0214011 | Mattawoman Creek |
| 12 | 021301 | Chincoteague Bay | 58 | 02130703 | Atkisson Reservoir | 104 | 0214020 | Potomac River U tidal |
| 13 | 021302 | Pocomoke Sound | 59 | 02130704 | Bynum Run | 105 | 0214020 | Potomac River MO Cnty |
| 14 | 021302 | Lower Pocomoke River | 60 | 02130705 | Aberdeen Proving Ground | 106 | 0214020 | Piscataway Creek |
| 15 | 021302 | Upper Pocomoke River | 61 | 02130706 | Swan Creek | 107 | 0214020 | Oxon Creek |
| 16 | 021302 | Dividing Creek | 62 | 02130801 | Gunpowder River | 108 | 0214020 | Anacostia River |
| 17 | 021302 | Nassawango Creek | 63 | 02130802 | Lower Gunpowder Falls | 109 | 0214020 | Rock Creek |
| 18 | 021302 | Tangier Sound | 64 | 02130803 | Bird River | 110 | 0214020 | Cabin John Creek |
| 19 | 021302 | Big Annemessex River | 65 | 02130804 | Little Gunpowder Falls | 111 | 0214020 | Seneca Creek |
| 20 | 021302 | Manokin River | 66 | 02130805 | Loch Raven Reservoir | 112 | 0214030 | Potomac River FR Cnty |
| 21 | 021303 | Lower Wicomico River | 67 | 02130806 | Prettyboy Reservoir | 113 | 0214030 | Lower Monocacy River |
| 22 | 021303 | Monie Bay | 68 | 02130807 | Middle River - Browns | 114 | 0214030 | Upper Monocacy River |
| 23 | 021303 | Wicomico Creek | 69 | 02130901 | Back River | 115 | 0214030 | Double Pipe Creek |
| 24 | 021303 | Wicomico River Head | 70 | 02130902 | Bodkin Creek | 116 | 0214030 | Catoctin Creek |
| 25 | 021303 | Nanticoke River | 71 | 02130903 | Baltimore Harbor | 117 | 0214050 | Potomac River WA Cnty |
| 26 | 021303 | Marshyhope Creek | 72 | 02130904 | Jones Falls | 118 | 0214050 | Antietam Creek |
| 27 | 021303 | Fishing Bay | 73 | 02130905 | Gwynns Falls | 119 | 0214050 | Marsh Run |
| 28 | 021303 | Transquaking River | 74 | 02130906 | Patapsco River L N Br | 120 | 0214050 | Conococheague Creek |
| 29 | 021304 | Honga River | 75 | 02130907 | Liberty Reservoir | 121 | 0214050 | Little Conococheague |
| 30 | 021304 | Little Choptank | 76 | 02130908 | S Branch Patapsco | 122 | 0214050 | Licking Creek |
| 31 | 021304 | Lower Choptank | 77 | 02131001 | Magothy River | 123 | 0214050 | Tonoloway Creek |
| 32 | 021304 | Upper Choptank | 78 | 02131002 | Severn River | 124 | 0214050 | Potomac River AL Cnty |
| 33 | 021304 | Tuckahoe Creek | 79 | 02131003 | South River | 125 | 0214050 | Little Tonoloway Creek |
| 34 | 021305 | Eastern Bay | 80 | 02131004 | West River | 126 | 0214051 | Sideling Hill Creek |
| 35 | 021305 | Miles River | 81 | 02131005 | West Chesapeake Bay | 127 | 0214051 | Fifteen Mile Creek |
| 36 | 021305 | Wye River | 82 | 02131101 | Patuxent River lower | 128 | 0214051 | Town Creek |
| 37 | 021305 | Kent Narrows | 83 | 02131102 | Patuxent River middle | 129 | 0214100 | Potomac River L N Branch |
| 38 | 021305 | Lower Chester River | 84 | 02131103 | Western Branch | 130 | 0214100 | Evitts Creek |
| 39 | 021305 | Langford Creek | 85 | 02131104 | Patuxent River upper | 131 | 0214100 | Wills Creek |
| 40 | 021305 | Corsica River | 86 | 02131105 | Little Patuxent River | 132 | 0214100 | Georges Creek |
| 41 | 021305 | Southeast Creek | 87 | 02131106 | Middle Patuxent River | 133 | 0214100 | Potomac River U N Branch |
| 42 | 021305 | Middle Chester River | 88 | 02131107 | Rocky Gorge Dam | 134 | 0214100 | Savage River |
| 43 | 021305 | Upper Chester River | 89 | 02131108 | Brighton Dam | 135 | 0502020 | Youghiogheny River |
| 44 | 021305 | Kent Island Bay | 90 | 02139996 | Upper Chesapeake Bay | 136 | 0502020 | Little Youghiogheny R |
| 45 | 021306 | Lower Elk River | 91 | 02139997 | Middle Chesapeake Bay | 137 | 0502020 | Deep Creek Lake |
| 46 | 021306 | Bohemia River | 92 | 02139998 | Lower Chesapeake Bay | 138 | 0502020 | Casselman River |

(noted by asterisk in Table 1). Fifteen stations, therefore, remain as candidates for sampling frequency reductions from monthly to bi-monthly with no loss in temporal trends information. The specific stations at which sampling frequency may be reduced are shown in Table 4.

The proposed modification is to reduce the frequency of sampling at two of the existing stations identified in Table 4 to make it possible to establish monthly sampling at one new station and retain bi-monthly sampling at the two existing stations. Since 15 existing Core/Trends stations are candidates for reduced sampling frequency, we can increase this monitoring network by up to 7 new stations. Practicality must be considered when:

1. the new station is located a great distance from where reduced sampling frequency stations occur (i.e., the same field crew may not be able to get to the new station within a daily work schedule).

2. sample analysis and QA/QC procedures may not follow a linear rule; i.e., sample frequency reduction does not allow QA/QC procedures to be cut in half to offset the addition of a new station,

3. stations where the focal water quality parameters are statistically "stable" today may change in response to future land use changes which will require an audit protocol of those stations to determine when trends are no longer able to be detected or, conversely, when variance is reduced enough to produce a statistically significant trend at the $p<0.01$ level.

However, based on the analyses of the Core/Trends Network described here, reduction in sampling frequency at these 15 stations should allow seven new stations to be added to this water quality monitoring network.

It should be emphasized here that non-tidal Core/Trends concentration values will underestimate loads (and yields) unless additional effort is made to collect the samples over a range of flow condition. It may be possible to correct this situation by sampling over a range of flows to establish the flow/concentration relationship at each station but this could not be done without additional cost to the program, and this problem will not be addressed by recommendations made in this report.

These seven new stations should be located in streams where flow gages exist to provide consistent concentration and flow estimates that can be used to calculate focal parameter loads (kg/yr) leaving the watershed and yields (kg/ha) from the watershed (the constituent load normalized to watershed area).

**Recommendation for New Station Locations**

The current non-tidal Core/Trends Network of water quality sampling stations (Figure 1) shows that the eastern shore of Maryland and the southern coastal plain are under-represented areas. There are currently eight operating USGS flow gauges within these areas that are not paired with water quality measurements (Table 5). Sampling at seven of the eight locations would add seven additional watersheds to the Core/Trends Network (note: the Chester River watershed could contain

## Table 4. Candidate Core/Trend Stations for Reduced Sampling Frequency

8/25/2000

| C/T # | Site Name | Water Quality Core | Water Quality Trend | US Geological Survey Gage # | US Geological Survey Discontinued | Stream Basin | County | MD 8-Digit | Map Key |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NBP0689 | X | | 1595500 | 1985 | North Branch Potomac | Garrett | 2141005 | 133 |
| 5 | NBP0461* | | X | | | North Branch Potomac | Allegany | 2141001 | 129 |
| 7 | BDK0000* | | X | | | Braddock Run | Allegany | 2141003 | 131 |
| 9 | NBP0103 | X | | | | North Branch Potomac | Allegany | 2141001 | 129 |
| 10 | NBP0023* | | X | | | North Branch Potomac | Allegany | 2141001 | 129 |
| 12 | POT2766* | | X | 1610000 | | Potomac River | Allegany | 2140508 | 124 |
| 17 | ANT0366 | | X | 1619000 | 1981 | Antietam Creek | Washington | 2140502 | 118 |
| 20 | CAC0148 | | X | 1637500 | | Catoctin Creek | Frederick | 2140305 | 116 |
| 22 | POT1595(MD) | | X | 1638500 | | Potomac River | Frederick | 2140301 | 112 |
| 30 | POT1472(VA) | | X | | | Potomac River | Montgomery | 2140202 | 105 |
| 32 | CJB0005 | | X | | | Cabin John Branch | Montgomery | 2140207 | 110 |
| 34 | RCM0111 | | X | | | Rock Creek | Montgomery | 2140206 | 109 |
| 36 | PXT0972 | X | | 1591000 | | Patuxent River | Montgomery | 2131108 | 89 |
| 39 | NPA0165 | X | | 1586000 | | North Br. Patapsco | Carroll | 2130907 | 75 |
| 41 | PAT0176 | X | | | | Patapsco | Baltimore | 2130906 | 74 |
| 42 | GWN0115 | X | | 1589300 | 1998 | Gwynns Falls | Baltimore | 2130905 | 73 |
| 43 | JON0184 | X | | 1589440 | | Jones Falls | Baltimore | 2130904 | 72 |
| 46 | GUN0125 | X | | | | Gunpowder River | Baltimore | 2130802 | 63 |
| 49 | CHO0626 | X | | 1491000 | | Choptank River | Caroline | 2130404 | 32 |
| 50 | CAS0479* | | X | 3078000 | | Casselman River | Garrett | 5020204 | 138 |
| 53 | YOU1139* | | X | | | Youghiogheny River | Garrett | 5020201 | 135 |

* Sampling at these sites was suspended in April, 1999 because of budgetary deficiencies.

# Table 5. Potential New Stations in Gaged Watersheds

**8/25/2000**

| Map # | Watershed Name | Stream Name | USGS Gauge # | Watershed Area (Mi2) | MD 8-Digit | Map Reference # |
|---|---|---|---|---|---|---|
| 55 | Upper Pocomoke | Pocomoke River | 1485000 | 60.5 | 2130203 | 15 |
| 56 | Pocomoke River | Nassawango Creek | 1485500 | 44.9 | 2130205 | 17 |
| 57 | Upper Chester | Unicorn Branch | 1493000 | 19.7 | 2130510 | 43 |
| 58 | Upper Chester | Morgan Creek | 1493500 | 12.7 | 2130510 | 43 |
| 59 | Big Elk Creek | Big Elk Creek | 1495000 | 52.6 | 2130606 | 51 |
| 60 | St Mary’s River | St. Mary’s River | 1661500 | 24 | 2140103 | 95 |
| 61 | St Clements Creek | St Clements Creek | 1661000 | 18.5 | 2140105 | 97 |
| 62 | Zekiah Swamp | Wicomoco River | 1660900 | 79.9 | 2140108 | 100 |

two water quality stations, (see Figure 2, Map Key # 43) totaling approximately 300 additional square miles of coverage (Table 5).

Marshyhope Creek and the Nanticoke River also are gauged, but these stations are not being considered for expansion of the Core/Trends Network because these gauge locations are in Delaware. The distance between the gauges and the Maryland border would underestimate the loads of water quality constituents being delivered to Maryland because the overland flow from an indeterminate area between the gauge and the Maryland border would enter the stream and not be counted in the load estimate.

Another possibility is to restore the stations at which sampling was suspended in April 1999. Six of the suspended stations met the criteria for reduced sampling frequency (Table 4). These stations may be restarted at reduced frequency and allow a one for one substitution in exchange for reduced sampling frequency at currently operating stations in Table 4. All of the stations where sampling has been suspended (marked by asterisks in Table l) could be restored to the network by doing a one-for- one exchange for those six suspended stations listed in Table 4. Sampling frequency at the remaining ten operating stations in Table 4 may be reduced in half to bring the five remaining suspended stations back into the network.

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# APPENDIX

## Summary of Comparison Between Trend Analysis with the Monthly Data Set and Analysis Using Every Other Month.

Note: an "X" in a cell below indicates that neither data set yielded a significant trend or they both did. If there is no "X", the results did not agree.

| Map | Station | TN | | TP | | TSS | |
|---|---|---|---|---|---|---|---|
| # | Name | Neither | Both | Neither | Both | Neither | Both |
| 1 | NBP0689 | X | | X | | X | |
| 2 | NBP0534 | | | X | | X | |
| 3 | SAV0000* | | X | X | | | |
| 4 | GEO0009 | | X | X | | X | |
| 5 | NBP0461* | | X | X | | X | |
| 6 | NBP0326 | | X | | | X | |
| 7 | BDK0000* | X | | X | | X | |
| 8 | WIL0013* | | | X | | X | |
| 9 | NBP0103 | | X | X | | X | |
| 10 | NBP0023* | | X | X | | X | |
| 11 | TOW0030 | | | X | | X | |
| 12 | POT2766* | X | | X | | X | |
| 13 | POT2386 | | | X | | X | |
| 14 | CON0180 | | | | | X | |
| 15 | CON0005 | | | | | X | |
| 16 | POT1830 | | X | | | X | |
| 17 | ANT0366 | X | | | | X | |
| 18 | ANT0203 | | X | | | | |
| 19 | ANT0044 | | | X | | X | |
| 20 | CAC0148 | X | | X | | X | |
| 21 | CAC0031 | | | X | | X | |
| 22 | POT1595(MD) | X | | X | | X | |
| 23 | POT1596(VA) | | | | | X | |
| 24 | MON0528 | | X | | | X | |
| 25 | BPC0035 | X | | X | | X | |
| 26 | MON0269 | | | X | | X | |
| 27 | MON 0155 | X | | X | | X | |
| 28 | MON0020 | X | | X | | X | |
| 29 | POT1471(MD) | | | X | | X | |
| 30 | POT1472(VA) | X | | X | | X | |
| 31 | SEN0008 | | X | | | X | |
| 32 | CJB0005 | X | | X | | X | |
| 33 | POT1184 | | | X | | X | |
| 34 | RCM0111 | X | | X | | X | |
| 35 | ANA0082 | X | | X | | X | |
| 36 | PXT0972 | X | | X | | X | |
| 37 | PXT0809 | | | X | | | |
| 38 | PXT0603 | | X | | | X | |
| 39 | NPA0165 | | X | X | | X | |
| 40 | PAT0285 | X | | | | X | |
| 41 | PAT0176 | X | | X | | X | |
| 42 | GWN0115 | X | | X | | X | |
| 43 | JON0184 | X | | X | | X | |
| 44 | GUN0476 | X | | | | X | |
| 45 | GUN0258 | | | X | | X | |
| 46 | GUN0125 | X | | X | | X | |
| 47 | SUS0109 | | | X | | X | |
| 48 | DER0015 | | | X | | X | |
| 59 | CHO0626 | X | | X | | X | |
| 50 | CAS0479* | | X | X | | X | |
| 51 | CCR0001* | | | X | | X | |
| 52 | YOU0925* | | | X | | X | |
| 53 | YOU1139* | | X | X | | X | |
| 54 | LYO0004* | | | X | | X | |

| | | Total Nitrogen | | | | Total Phosphorus | | | | Total Suspended Solids | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site # | Station Name | % Change | p-value | Median | Status | % Change | p-value | Median | Status | % Change | p-value | Median | Status |
| 1 | NBP0689 | -5.17 | 0.5916 | 1.2865 | GOOD | 0 | 0.9284 | 0.0165 | GOOD | -22.65 | 0.0383 | 6 | FAIR |
| 2 | NBP0534 | -16.38 | 0.0032 | 1.142 | GOOD | 0 | 0.2178 | 0.0145 | GOOD | 0 | 0.1011 | 4 | GOOD |
| 3 | SAV0000 | -39.81 | 0 | 0.828 | GOOD | 0 | 0.9813 | 0.011 | GOOD | 0 | 0.092 | 4 | GOOD |
| 4 | GEO0009 | -31.04 | 0 | 1.223 | GOOD | -6.33 | 0.4263 | 0.048 | FAIR | 18.29 | 0.1861 | 18 | POOR |
| 5 | NBP0461 | -26.77 | 0 | 1.131 | GOOD | -18.45 | 0.2143 | 0.046 | FAIR | 0 | 0.7622 | 12 | POOR |
| 6 | NBP0326 | -23.76 | 0 | 1.1565 | GOOD | -22.22 | 0.0426 | 0.0455 | FAIR | 0 | 0.9221 | 11 | POOR |
| 7 | BDK0000 | -37.49 | 0.05 | 0.651 | GOOD | 0 | 0.4891 | 0.02 | GOOD | 24.07 | 0.1237 | 10 | POOR |
| 8 | WIL0013 | -29.02 | 0.001 | 1.015 | GOOD | 12.3 | 0.0676 | 0.019 | GOOD | 0 | 0.7633 | 4 | GOOD |
| 9 | NBP0103 | -29.58 | 0 | 1.316 | FAIR | -10.91 | 0.4966 | 0.062 | FAIR | 0 | 0.9686 | 9 | POOR |
| 10 | NBP0023 | -28.88 | 0 | 1.233 | GOOD | -9.22 | 0.5279 | 0.062 | FAIR | 0 | 0.7798 | 10 | POOR |
| 11 | TOW0030 | -39.73 | 0.0047 | 0.752 | GOOD | 0 | 0.5387 | 0.019 | GOOD | 0 | 0.0427 | 3 | GOOD |
| 12 | POT2766 | -11.66 | 0.1369 | 0.9775 | GOOD | 0 | 0.9649 | 0.0335 | GOOD | 0 | 0.7893 | 8 | FAIR |
| 13 | POT2386 | -35.73 | 0 | 0.941 | GOOD | -14.6 | 0.3468 | 0.027 | GOOD | 11.82 | 0.3694 | 8 | FAIR |
| 14 | CON0180 | -18.84 | 0.0002 | 4.249 | POOR | -49.04 | 0 | 0.1 | POOR | 7.38 | 0.4195 | 10 | POOR |
| 15 | CON0005 | -21.42 | 0.0003 | 4.4335 | POOR | -38 | 0.0002 | 0.105 | POOR | 40.35 | 0.0444 | 10.5 | POOR |
| 16 | POT1830 | -24.12 | 0.0001 | 1.6185 | FAIR | -23.11 | 0.0954 | 0.04 | FAIR | 19.6 | 0.2264 | 5.25 | GOOD |
| 17 | ANT0366 | -6.63 | 0.039 | 5.0705 | POOR | -46.82 | 0 | 0.102 | POOR | 33.26 | 0.1178 | 15 | POOR |
| 18 | ANT0203 | -15.01 | 0 | 5.966 | POOR | -26.14 | 0.0048 | 0.187 | POOR | 68.4 | 0.0075 | 18.5 | POOR |
| 19 | ANT0044 | -9.38 | 0.0074 | 5.369 | POOR | -16.89 | 0.0608 | 0.161 | POOR | 15.82 | 0.4006 | 9 | POOR |
| 20 | CAC0148 | -14.36 | 0.0329 | 1.663 | FAIR | -6.61 | 0.3948 | 0.057 | FAIR | 64.98 | 0.0667 | 5 | GOOD |
| 21 | CAC0031 | -30.44 | 0.0067 | 2.304 | POOR | -14.01 | 0.334 | 0.0825 | POOR | 61.89 | 0.146 | 7 | FAIR |
| 22 | POT1595 | -19.25 | 0.0113 | 1.956 | FAIR | -25.99 | 0.07 | 0.048 | FAIR | 0 | 0.5156 | 7.5 | FAIR |
| 23 | POT1596 | -20.03 | 0.003 | 1.767 | FAIR | -42.75 | 0.002 | 0.049 | FAIR | 0 | 0.6223 | 8.5 | FAIR |
| 24 | MON0528 | -74.52 | 0 | 1.862 | FAIR | -24.58 | 0.0005 | 0.106 | POOR | 0 | 0.5273 | 10 | POOR |
| 25 | BPC0035 | 0 | 0.9227 | 3.992 | POOR | -22.8 | 0.136 | 0.045 | FAIR | 0 | 0.3202 | 8 | FAIR |
| 26 | MON0269 | -31.85 | 0.0006 | 2.836 | POOR | -23.16 | 0.0834 | 0.08 | POOR | 38.17 | 0.2063 | 7 | FAIR |
| 27 | MON0155 | -5.62 | 0.5811 | 3.479 | POOR | 6.48 | 0.4832 | 0.1505 | POOR | 50.64 | 0.2607 | 11 | POOR |
| 28 | MON0020 | -13.56 | 0.0101 | 3.629 | POOR | 0 | 0.9543 | 0.134 | POOR | 79.98 | 0.0181 | 10 | POOR |
| 29 | POT1471 | -29.21 | 0.0006 | 2.0905 | FAIR | -22.05 | 0.021 | 0.059 | FAIR | 0 | 0.8725 | 9 | POOR |
| 30 | POT1472 | -17.64 | 0.0102 | 1.7265 | FAIR | -27.18 | 0.0472 | 0.048 | FAIR | 0 | 0.9848 | 7.5 | FAIR |
| 31 | SEN0008 | -29.95 | 0 | 2.898 | POOR | -27.57 | 0.0081 | 0.1085 | POOR | 32.49 | 0.0577 | 9 | POOR |
| 32 | CJB0005 | 8.63 | 0.1954 | 1.7025 | FAIR | -41.26 | 0.1644 | 0.0265 | GOOD | 162.46 | 0.0238 | 4 | GOOD |
| 33 | POT1184 | -19.61 | 0.0012 | 1.804 | FAIR | -25.85 | 0.1549 | 0.05 | FAIR | 129.97 | 0.0143 | 16 | POOR |
| 34 | RCM0111 | 3.59 | 0.5424 | 1.832 | FAIR | -19.86 | 0.173 | 0.055 | FAIR | 39.13 | 0.2377 | 8.5 | FAIR |
| 35 | ANA0082 | -2.92 | 0.661 | 1.6575 | FAIR | -24.37 | 0.3068 | 0.0445 | FAIR | 0 | 0.5518 | 7.5 | FAIR |
| 36 | PXT0972 | 9.98 | 0.0425 | 2.9345 | POOR | -30.78 | 0.0155 | 0.0255 | GOOD | 0 | 0.3947 | 8 | FAIR |

Trends: 1986-1998

| Site # | Station Name | Total Nitrogen % Change | p-value | Median | Status | Total Phosphorus % Change | p-value | Median | Status | Total Suspended Solids % Change | p-value | Median | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | PXT0809 | 22.47 | 0.0002 | 1.913 | FAIR | 26.26 | 0.1449 | 0.031 | GOOD | 72.2 | 0.003 | 8 | FAIR |
| 38 | PXT0603 | -56.85 | 0 | 2.1431 | FAIR | -46.91 | 0 | 0.0876 | POOR | -11.84 | 0.3461 | 10.3 | POOR |
| 39 | NPA0165 | 28.39 | 0 | 4.801 | POOR | -39.53 | 0.0735 | 0.0175 | GOOD | 0 | 0.3528 | 4 | GOOD |
| 40 | PAT0285 | 15.6 | 0.0444 | 2.986 | POOR | -43.56 | 0.0005 | 0.048 | FAIR | 0 | 0.4292 | 6 | FAIR |
| 41 | PAT0176 | 16.37 | 0.0211 | 2.53 | POOR | -21.52 | 0.0481 | 0.049 | FAIR | 0 | 0.9856 | 5 | GOOD |
| 42 | GWN0115 | -4.3 | 0.4142 | 1.9945 | FAIR | -23.37 | 0.1683 | 0.0255 | GOOD | 0 | 0.6691 | 4 | GOOD |
| 43 | JON0184 | 3.31 | 0.4838 | 2.1285 | FAIR | -32.57 | 0.1054 | 0.02 | GOOD | 0 | 0.5108 | 4 | GOOD |
| 44 | GUN0476 | 9.84 | 0.0135 | 3.4565 | POOR | -36.1 | 0.0072 | 0.027 | GOOD | 23.58 | 0.1922 | 6 | FAIR |
| 45 | GUN0258 | 13.83 | 0.0029 | 2.7715 | POOR | 0 | 0.5696 | 0.02 | GOOD | 39.2 | 0.0706 | 5 | GOOD |
| 46 | GUN0125 | 9.54 | 0.4487 | 2.1335 | FAIR | -30.58 | 0.0757 | 0.0295 | GOOD | -20.63 | 0.3402 | 8 | FAIR |
| 47 | SUS0109 | -16.83 | 0.0133 | 1.6755 | FAIR | -11.4 | 0.1296 | 0.043 | FAIR | 37.13 | 0.0379 | 9 | POOR |
| 48 | DER0015 | 13.45 | 0.0025 | 3.8555 | POOR | -5.91 | 0.752 | 0.031 | GOOD | 72.2 | 0.0365 | 4 | GOOD |
| 49 | CHO0626 | 4.94 | 0.5213 | 1.8285 | FAIR | 15.6 | 0.2437 | 0.052 | FAIR | 0 | 0.7462 | 3.5 | GOOD |
| 50 | CAS0479 | -35.95 | 0 | 0.784 | GOOD | 0 | 0.5422 | 0.028 | GOOD | 0 | 0.2567 | 5 | GOOD |
| 51 | CCR0001 | -22.39 | 0.0108 | 0.479 | GOOD | 0 | 0.0841 | 0.022 | GOOD | 0 | 0.6956 | 6 | FAIR |
| 52 | YOU0925 | -27.64 | 0.0001 | 0.823 | GOOD | 0 | 0.6403 | 0.022 | GOOD | 0 | 0.2685 | 6 | FAIR |
| 53 | YOU1139 | -43.02 | 0 | 1.015 | GOOD | -25.82 | 0.1136 | 0.031 | GOOD | 0 | 0.7831 | 12 | POOR |
| 54 | LYO0004 | -26.04 | 0.007 | 1.588 | FAIR | -10.13 | 0.3469 | 0.07 | FAIR | 0 | 0.9395 | 14 | POOR |